Anatomical Characteristics of the Cerebral Surface in Bulimia Nervosa

Supplemental Information

Supplemental Methods & Materials

Participants

Formal diagnoses of bulimia nervosa (BN) and the presence of comorbid neuropsychiatric diagnoses were established using the Structured Clinical Interview for DSM Disorders (1) for adults and adolescents over eighteen years of age and the Kiddie-SADS-Present and Lifetime Version (2) for those under eighteen. Bulimic symptom severity and prior diagnoses of anorexia nervosa were assessed using the Eating Disorder Examination (3). The Beck Depression Inventory-II (4) and the Hamilton Depression Scale (5) quantified depressive symptoms for those over eighteen, and the Child Depression Rating Scale (6) was used for those under eighteen. The DuPaul-Barkley Attention-Deficit Hyperactivity Disorder Rating Scale quantified symptoms of inattention and hyperactivity (7). Full-scale IQs were estimated using the Wechsler Abbreviated Scale of Intelligence (8).

Stroop Interference

Stroop interference was measured outside the scanner using the standard format of the Stroop task (9). In task A (color naming), participants were asked to name as quickly as possible the color (red, green, or blue) of 126 dots, 5.6 mm in diameter, arrayed randomly in 9 columns and 14 rows on an 8.5 x 11 inch sheet of white paper, scanned left to right and then top to bottom. In B (word reading), they were asked to read as quickly as possible an equal number of similarly arrayed words ("red", "green", or "blue") printed in black ink. In C (color-word naming), they were asked to name as quickly as possible the ink color of a similar array of words written in incongruent colors. The time to completion of each task was recorded (A, B, and C, respectively). Stroop interference was calculated as C-[(AxB)/(A+C)](10). These behavioral measures, conducted either before or after the scanning session for each participant, were used in correlation analyses with measures of surface morphology.

Supplemental Results

Table S1. Demographic, Clinical, and Neuropsychological Characteristics of Participants

	Participants		
Characteristic	**BN (*n* = 34)**	**HC (*n* = 34)**	**Test Statistic**
Age, y	21.6 (6.0, range 13-46)	22.08 (6.5, range 15-40)	$t_{66} = -0.31$; $p = 0.75$
BMI	22.10 (2.0, range 18-26)	22.13 (2.3, range 18-25)	$t_{66} = -0.6$; $p = 0.95$
Duration of Illness, yrs.	5.79 (5.8, range 1-16)	…	
EDE Ratings			
OBEs, past 28 days	38.3 (45.0, range 1-230)	…	
Vomiting episodes, past 28 days	61.6 (69.2, range 1-245)	…	
Preoccupation w/ shape & weight	3.3 (2.5, range 0-6)	…	
HAM-D/CDRS[1] Scores	12.9 (13.3)	…	
Past AN, # (%)	10 (29.4)	…	
Medication, # (%)	12 (35.3)	…	
Sub-clinical BN, # (%)[2]	6 (17.6)	…	
WASI IQ Scores			
Full-4	111.8 (10.5)	114.5 (13.3)	$t_{66} = -0.96$; $p = 0.34$
Verbal	111.3 (13.1)	118.2 (13.9)	$t_{66} = -2.1$; $p = 0.03$
Performance	109. 5 (11.8)	107.4 (12.7)	$t_{66} = 0.72$; $p = 0.47$
Stroop Interference	22.1 (6)	21.5 (5)	$t_{66} = 0.41$; $p = 0.68$

AN, anorexia nervosa; BMI, body mass index; CDRS, Children's Depression Rating Scale; EDE, Eating Disorders Examination; HAM-D, Hamilton Depression Rating Scale; HC, healthy controls; OBEs, objective bulimic episodes; WASI, Wechsler Abbreviated Scale of Intelligence.

*Values are mean (SD) unless otherwise specified.

[1]CDRS scores were collected in 5 adolescents with BN, HAM-D scores were collected in the other BN participants.

[2]BN participants who presented with sub-clinical BN, with less than 8 (2x/week) binge-eating (*n* = 2), vomiting (*n* = 2), or binge-eating and vomiting (*n* = 2) episodes over the past twenty-eight days prior to participation.

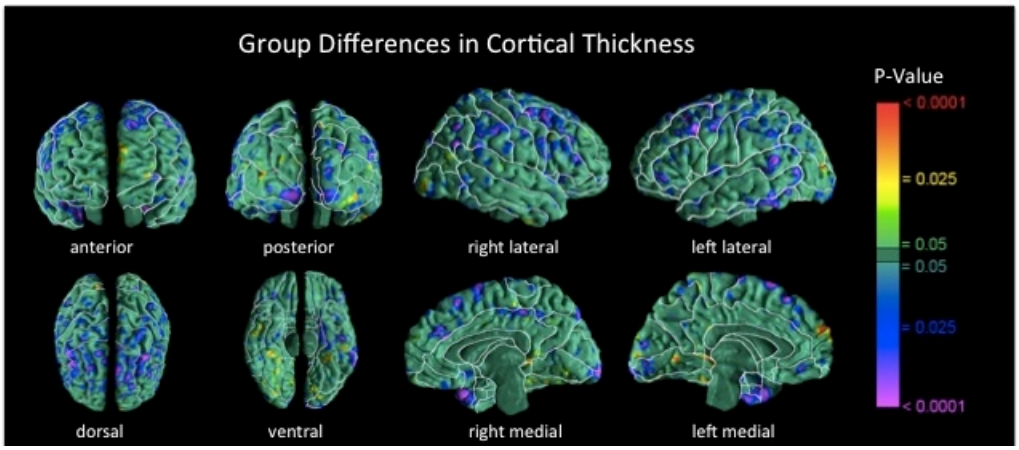

Figure S1. Maps of group differences in cortical thickness. Color-coded maps are shown for the statistical comparison of average differences in cortical thickness between the bulimia nervosa and control groups. The pattern of statistically significant differences is similar to the those depicted in the maps of *p* values comparing surface measures across groups (Figure 1), particularly in bilateral inferior frontal and precentral gyri.

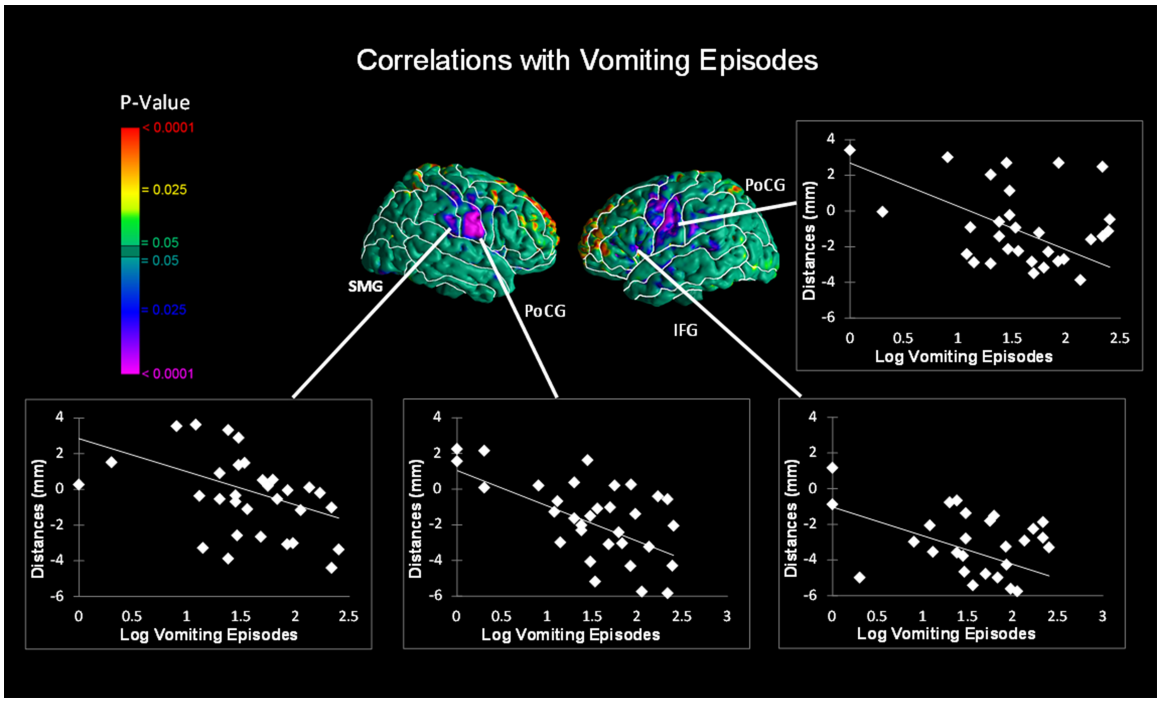

Figure S2. Correlations of cerebral surface morphology with vomiting episodes in the bulimia nervosa group. Warm colors (red and yellow) indicate positive correlations and cool colors (blue and purple) indicate inverse correlations between surface measures and log transformed vomiting episodes within the past 28 days prior to MRI scan. Surface distances (in mm from the corresponding point of the template brain), adjusted for age and duration of illness, are plotted on the y axis and log transformed vomiting episodes are plotted on the x axis. The scatterplots show greater reductions (larger indentations) in right inferior frontal gyrus, and in bilateral pre- and postcentral gyri, and supramarginal gyri with more severe symptoms. IFG, inferior frontal gyrus; PoCG, postcentral gyrus; SMG, supramarginal gyrus.

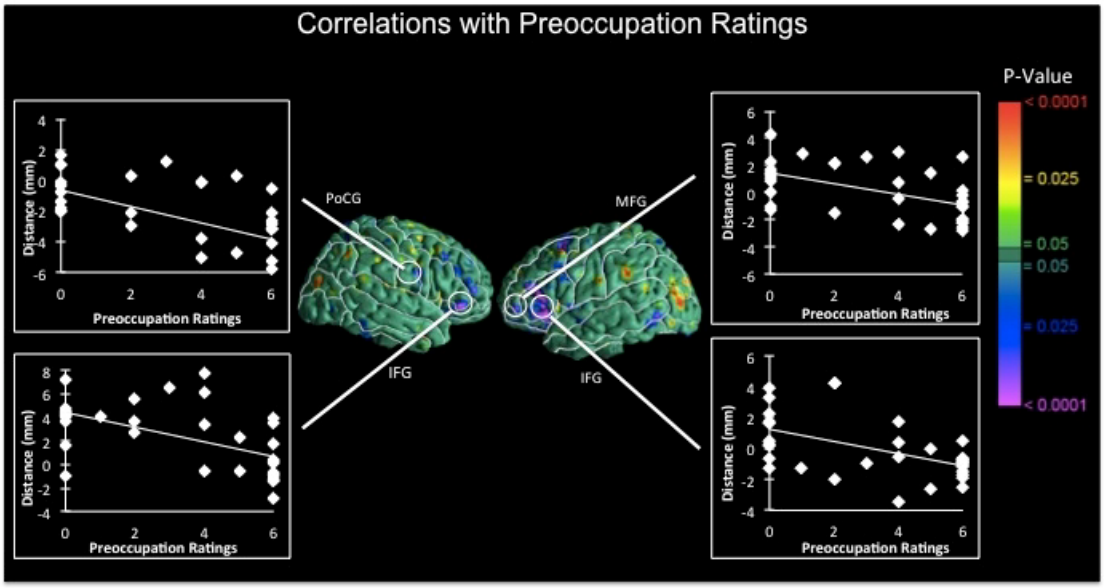

Figure S3. Correlations of surface morphology with ratings of preoccupation with shape and weight in the BN group. Warm colors (red and yellow) indicate positive correlations and cool colors (blue and purple) indicate inverse correlations between surface measures and preoccupation ratings. Surface distances (in mm from the corresponding point of the template brain), adjusted for duration of illness, are plotted on the y axis and ratings are plotted on the x axis. The scatterplots show greater reductions (larger indentations) in bilateral inferior frontal gyri, right postcentral gyrus, and left medial frontal gyrus in the BN participants who were the most preoccupied with shape and weight. BN, bulimia nervosa; IFG, inferior frontal gyrus; MFG, medial frontal gyrus; PoCG, postcentral gyrus.

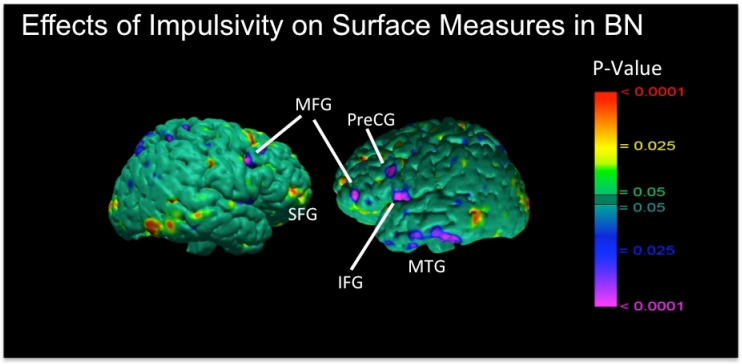

Figure S4. Correlations of surface measures impulsivity in the BN group. Warm colors (red and yellow) indicate positive correlations and cool colors (blue and purple) indicate inverse correlations between surface measures scores on three items on the DuPaul-Barkley ADHD Rating Scale that assess impulsivity: 'blurts out answers before questions have been completed,' 'has difficulty awaiting turn,' and 'interrupts or intrudes on others'. These maps suggest smaller local volumes (larger reductions or indentations) in left IFG and MTG, and bilateral MFG with more impulsivity. BN, bulimia nervosa; IFG, inferior frontal gyrus; MFG, medial frontal gyrus; MTG, medial temporal gyrus; PreCG, precentral gyrus; SFG, superior frontal gyrus.

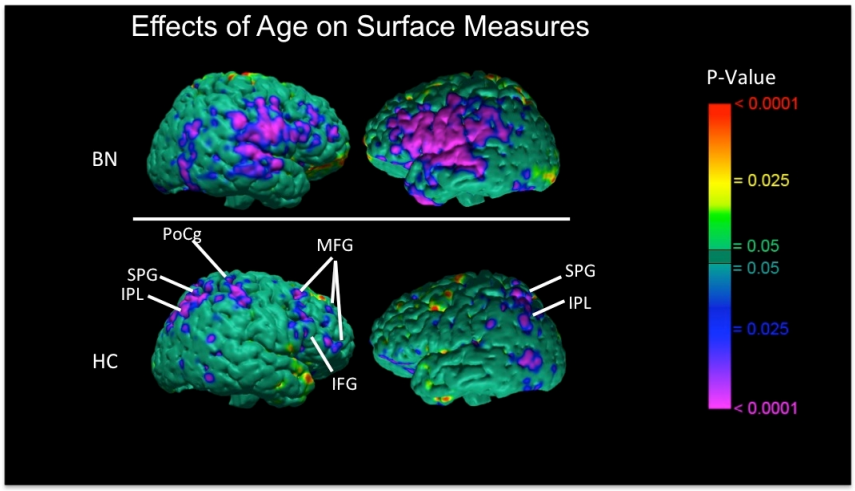

Figure S5. Effects of age in the BN and control groups. Cool colors (blue and purple) indicate inverse correlations between surface measures and age. Significant inverse correlations were detected in large expanses of bilateral frontal and temporal regions on the lateral surface in the BN group, suggesting smaller local volumes with increasing age. Inverse correlations with age were detected in right IFG, MFG and PoCg, and in bilateral IPL in controls. BN, bulimia nervosa; HC, healthy controls; IFG, inferior frontal gyrus; IPL, inferior parietal lobule; MFG, medial frontal gyrus; PoCg, postcentral gyrus; SPG, superior parietal gyrus.

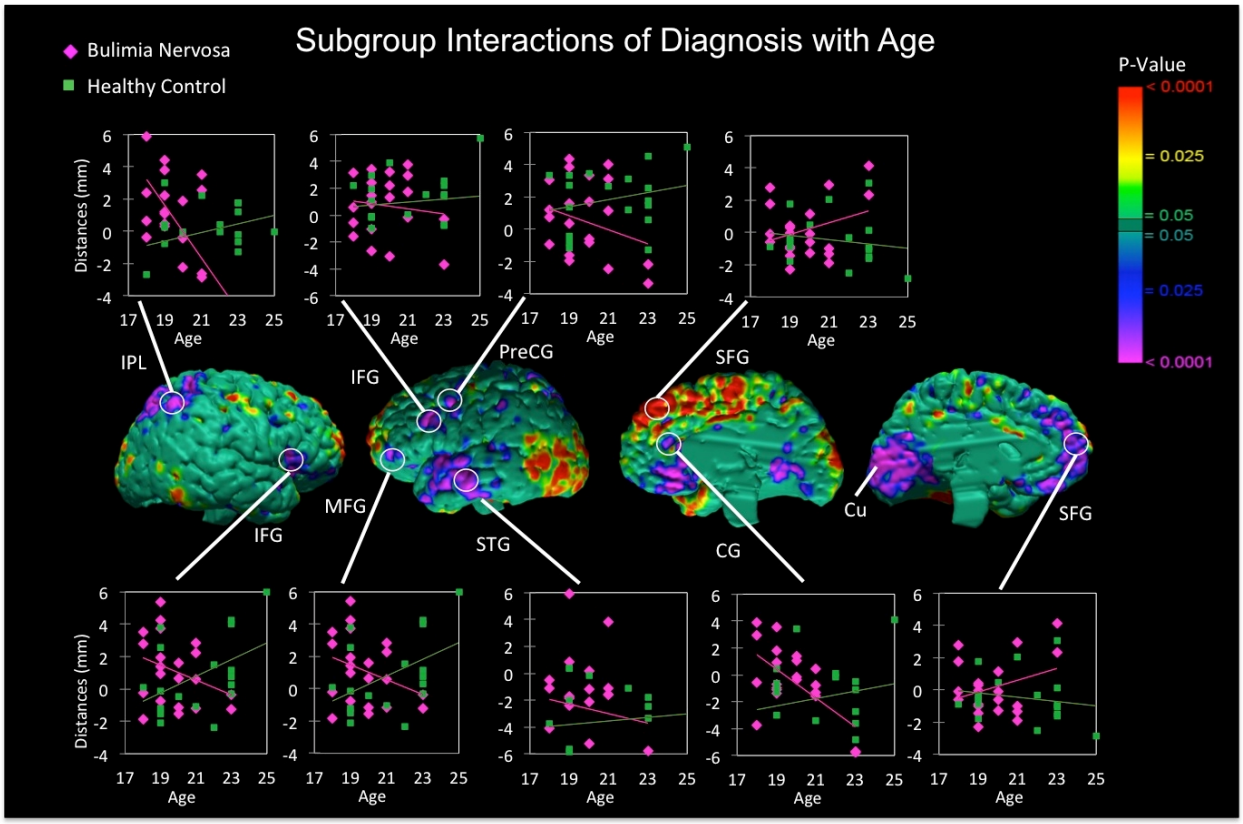

Figure S6. Correlations of surface morphology with age in BN vs. control subgroups. For this analysis, we included a subgroup of 21 BN participants (mean age = 20 years; mean illness duration = 4 years) in who age and illness duration was uncorrelated (r = 0.36; p = 0.1), and a subgroup of 18 age-

matched controls (mean age = 21). Diagnosis-by-age interactions remained significant in the BN subgroup in left IFG and MFG, and were also detected in left PreCG, SFG, IPL, MTG and STG, and right IFG such that age correlated inversely with reductions in these areas in the BN but not the control subgroups. In contrast, age correlated positively with enlargements in right SFG in the BN but not the control subgroups. BN, bulimia nervosa; CG, cingulate gyrus; Cu, cuneus; IFG, inferior frontal gyrus; IPL, inferior parietal lobule; MFG, medial frontal gyrus; MTG, medial temporal gyrus; PreCG, precentral gyrus; SFG, superior frontal gyrus; STG, superior temporal gyrus.

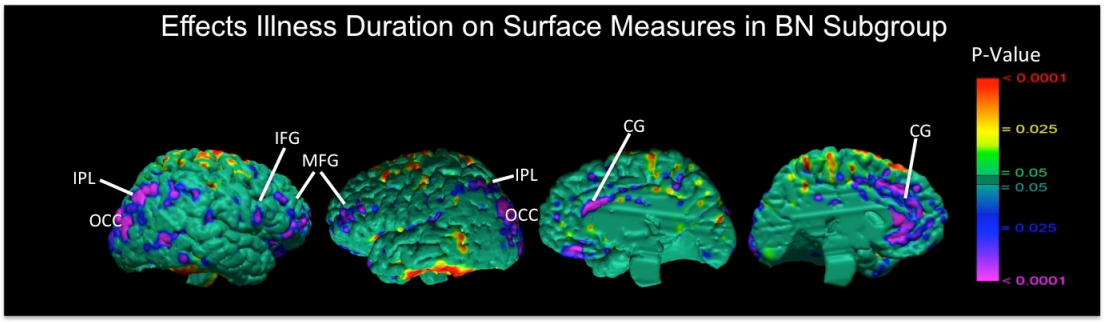

Figure S7. Effects of illness duration in the BN subgroup. Cool colors (blue and purple) indicate inverse correlations between surface measures and age (top) and illness duration (bottom) in a subgroup of 21 BN participants in who age and illness duration were uncorrelated (p = 0.00). Reductions in right IFG, bilateral MFG, CG, IPL, and OCC were associated inversely with illness duration in the BN subgroup. BN, bulimia nervosa; CG, cingulate gyrus; IFG, inferior frontal gyrus; IPL, inferior parietal lobule; MFG, medial frontal gyrus; OCC, occipital cortex.

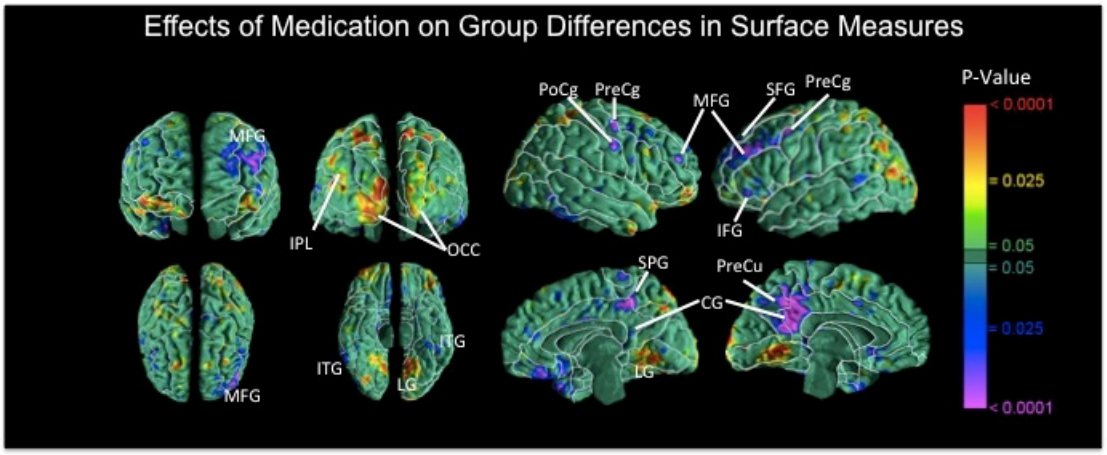

Figure S8. Effects of medication on group differences in surface measures. These analyses correspond to those shown in Figure 1, but covarying for the use of medication (serotonin reuptake inhibitors) in the BN participants. Findings in bilateral frontal cortices are essentially unchanged from findings from analyses that did not covary for medication. We additionally ran the same analysis including only the BN participants not on medication (n = 22). Both these analyses suggest that medication did not have an appreciable effect on our findings. BN, bulimia nervosa; CG, cingulate gyrus; IFG, inferior frontal gyrus; IPL, inferior parietal lobule; ITG, inferior temporal gyrus; LG, lingual gyrus; MFG, medial frontal gyrus; OCC, occipital cortex; PoCg, postcentral gyrus; PreCg, precentral gyrus; PreCu, precuneus; SFG, superior frontal gyrus; SPG, superior parietal gyrus.

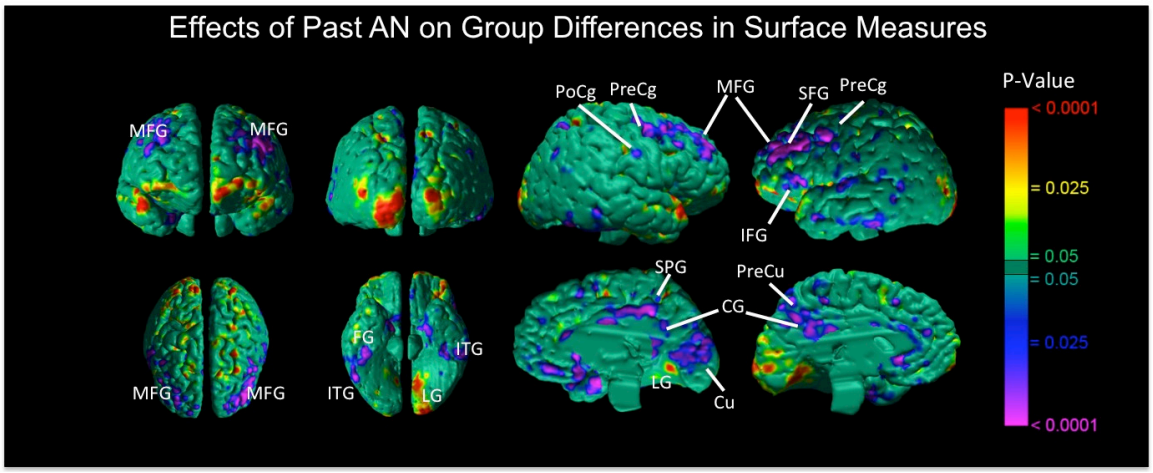

Figure S9. Effects of past AN on group differences in surface measures. These analyses correspond to those shown in Figure 1, but including only the BN participants who did not have a past diagnosis of AN. This analysis suggests that a past diagnosis of AN did not have an appreciable effect on our findings of group differences. AN, anorexia nervosa; BN, bulimia nervosa; CG, cingulate gyrus; Cu, cuneus; FG, fusiform gyrus; IFG, inferior frontal gyrus; ITG, inferior temporal gyrus; LG, lingual gyrus; MFG, medial frontal gyrus; PoCg, postcentral gyrus; PreCg, precentral gyrus; PreCu, precuneus; SFG, superior frontal gyrus; SPG, superior parietal gyrus.

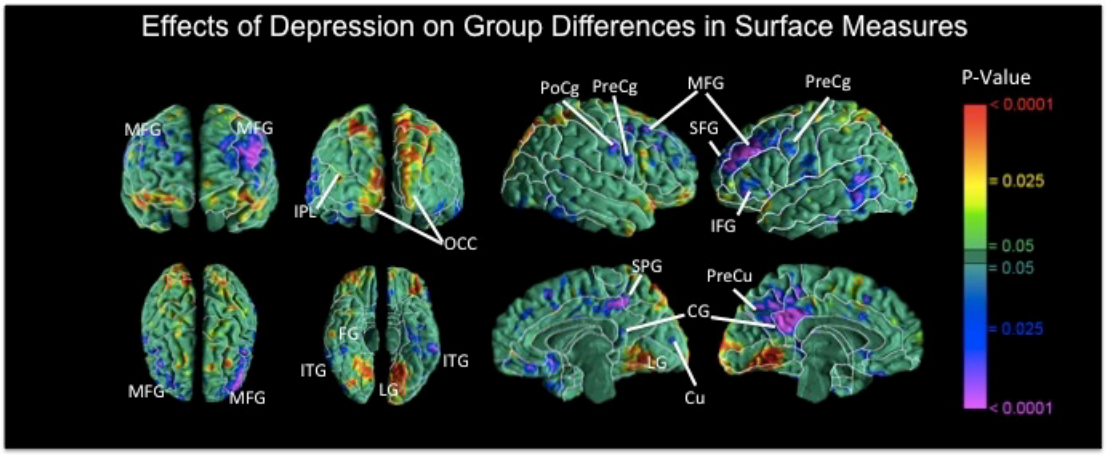

Figure S10. Effects of depression on group differences in surface measures. These analyses correspond to those shown in Figure 1, but including only the BN participants who scored less than 16 on the Hamilton Depression Rating Scale or Child Depression Rating Scale (n = 24). This analysis suggests that depression did not have an appreciable effect on our findings of group differences. CG, cingulate gyrus; Cu, cuneus; FG, fusiform gyrus; IFG, inferior frontal gyrus; IPL, inferior parietal lobule; ITG, inferior temporal gyrus; LG, lingual gyrus; MFG, medial frontal gyrus; OCC, occipital cortex; PoCg, postcentral gyrus; PreCg, precentral gyrus; PreCu, precuneus; SFG, superior frontal gyrus; SPG, superior parietal gyrus.

Supplemental References

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